BBC RD 1974/36

BBC

RESEARCH DEPARTMENT

1969 1974
THE QUEEN'S AWARD TO INDUSTRY

REPORT

A fixed-tuned medium-wave receiver suitable for a road traffic information service

D.E. Susans, M.I.E.E., M.I.E.R.E.

Research Department, Engineering Division
THE BRITISH BROADCASTING CORPORATION

October, 1974

BBC RD 1974/36
UDC 621.396.621.
656.05

A FIXED-TUNED MEDIUM-WAVE RECEIVER SUITABLE FOR A ROAD TRAFFIC INFORMATION SERVICE

D.E. Susans, M.I.E.E., M.I.E.R.E.

Summary

This report describes a medium-wave fixed-tuned receiver intended for use in a motorcar for the reception of a road traffic information service. Its main features are long-term tuning stability, good automatic gain control over the working signal-level range, and a carrier-level-operated muting circuit to suppress the output on weak input signals. The receiver and loudspeaker are in a single unit.

Issued under the authority of

P. Rainger

Head of Research Department

Research Department, Engineering Division,
BRITISH BROADCASTING CORPORATION

October, 1974
(EL-98)

A FIXED-TUNED MEDIUM-WAVE RECEIVER SUITABLE FOR A ROAD TRAFFIC INFORMATION SERVICE

A FIXED-TUNED MEDIUM-WAVE RECEIVER SUITABLE FOR A ROAD TRAFFIC INFORMATION SERVICE

D.E. Susans, M.I.E.E., M.I.E.R.E.

1. Introduction

It is envisaged at present that a road traffic information service might consist of a large number of low-power transmitters on a common medium-wave channel.[1] These transmitters would operate in a controlled time sequence so that in any area only one transmission would be received, above a predetermined threshold at any one time. If such a service were instituted, and were accepted by the motoring public, no doubt car radios would eventually be produced that provided facilities for receiving both it and the normal entertainment programmes. Initially, however, a separate road information service receiver would be desirable in order to make best use of the service, even if a normal car radio were already installed in the vehicle.

To avoid a continuous background of noise and interference, the receiver should be muted when the local transmitter is not radiating but this mute must have a delayed operation to avoid breaks due to momentary drop-outs such as those which can occur under bridges. A delay of about 10 seconds appears to be appropriate. A shorter delay, about 0·25 seconds, in the release on the mute avoids ignition spike breakthrough in the absence of a signal. It is essential to have a good a.g.c. circuit in order to prevent weak signals becoming inaudible against the high acoustic background noise or strong signals becoming sufficiently loud to disturb the driver's concentration.

In order not to produce interference to any other car radio that may be operating in the vehicle at the same time it is desirable for the traffic information receiver not to incorporate a local oscillator. A tuned-radio-frequency receiver is quite practicable without great difficulty at the low-frequency end of the medium-wave band. The receiver described here is of this type. No continuously-variable tuning control is provided but it can be aligned to any frequency in the range 520-600 kHz, by internal trimmer adjustments.

The final requirement is that the acoustic output of the receiver should be adequate for the message to be heard above vehicle noise and the programme from another car radio.

2. Circuit description

A circuit diagram is shown in Fig. 1. The receiver is designed for use with a window- or gutter-mounted clip-on rod aerial. This aerial and its associated feeder form part of an input resonant circuit whose selectivity reduces the possibility of overloading by unwanted transmissions elsewhere in the medium-wave band. The input stage TR1 has two functions, firstly it amplifies the input signal and secondly it acts as a d.c. amplifier for the a.g.c. which is applied to the following intergrated circuit IC1. A coupled pair of tuned circuits is used between the input amplifier TR1 and the integrated circuit IC1. This integrated circuit is primarily intended for use in a superheterodyne receiver but the local oscillator input has here been replaced by a d.c. input; thus there is no frequency changing. A second coupled-pair of tuned circuits is associated with IC1.

The detector used in this integrated circuit is an emitter follower with a large capacitative load C18. The d.c. component of the detector output is filtered by R14, 15, C19-21 and then amplified by a long-tailed pair d.c. amplifier TR3, TR1 to produce the a.g.c. control voltage for IC1. Resistors R6, R7 shift the d.c. output level of TR1 to a suitable range for this purpose. The d.c. gain of the amplifier is stabilised by negative feedback. A reference level for the a.g.c. is obtained from pin 13 of IC1, the preset control R16 being set to give maximum r.f. gain from the integrated circuit under no-signal conditions. The integrated circuit IC1 also contains an audio amplifier with external feedback to set its voltage gain to three times. The audio output (pin 6) is fed to the volume control R31 and power output amplifier IC2. This amplifier will give at least 3 watts into the built-in 3 ohm loudspeaker.

Muting is controlled from the current flowing in one of the integrated-circuit transistors. The a.g.c. applied to this transistor reduces its collector current as the signal level increases. When a sufficient reduction of current has occurred, as determined by the mute control R10, then TR2 will begin to conduct. The mute delay capacitor C22 is then charged via the emitter follower TR4 and isolating diode D1. The charge time is set by R20. When the voltage on this mute delay capacitor C22 exceeds a preset value, TR5 and hence TR6 will cut off. This releases the mute which was applied by the low impedance of TR6 across the volume control R31. The diode D2 prevents reverse breakdown of TR5 and limits the voltage on C22 thus maintaining a constant mute release time. When the input signal falls below the mute threshold, TR2 cuts-off. This allows D1 to cease conduction and C22 will discharge via R21, 22. After approximately 10 seconds transistor TR5 and hence TR6 will conduct, short-circuiting the volume control and thus silencing the audio output.

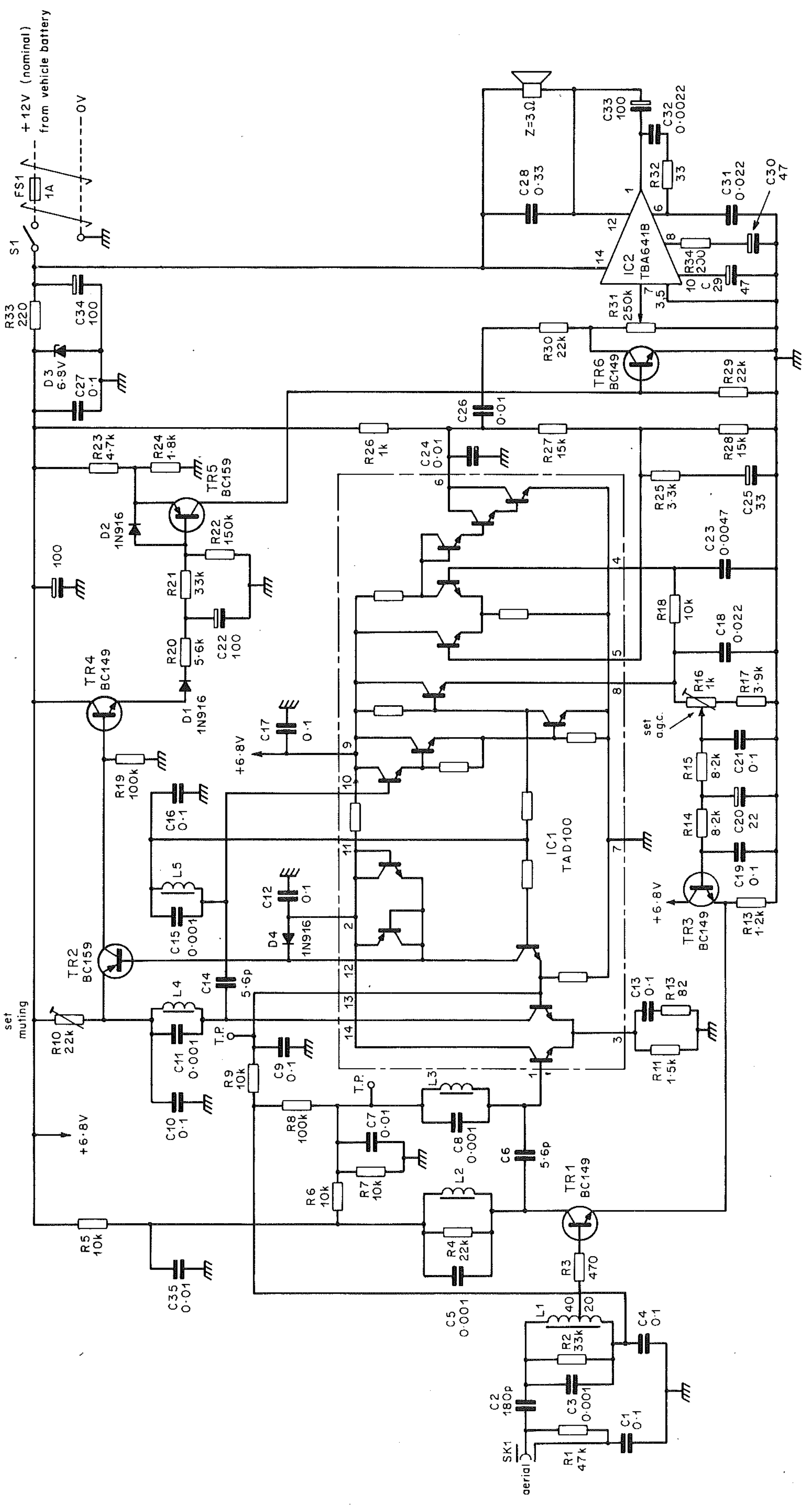

Fig. 1 - Circuit Diagram

The receiver together with its 6" x 4" loudspeaker is mounted in a plastic box. The power supplies are derived from the vehicle battery which, since the receiver is totally insulated with no other external d.c. connection, can have either its positive or negative terminal earthed. The supply to the r.f. and detector sections of the circuit is stabilised by a zener diode to ensure maximum stability of the mute threshold level.

3. Performance

The following performance characteristics relate to the receiver when mounted in a car, and using a commercial 800-mm-long window-mounted whip aerial. The measurement results apply with the receiver aligned on 593 kHz but check measurements on 557 kHz gave sensibly identical performance. During a short series of subjective tests on the road it was found that, although the receiver is satisfactory in fields down to 60 dBμ (1 mV/m) under quiet conditions, under conditions of normal urban traffic, ignition interference from other vehicles tends to degrade the signal-to-noise ratio rapidly as the field strength falls below about 70 dBμ (3 mV/m). For the objective tests, therefore, the mute was adjusted to operate at an input signal level corresponding to a field strength of 3 mV/m with the particular combination of car and aerial used in the road tests. In the measurement results, input signal levels are quoted in terms of field strength, assuming this type of aerial.

Figure 2 shows the input-output characteristic of the receiver whilst Figure 3 shows the mute characteristic. It will be seen that, over an input signal range from 3 mV/m up to the overload point, the output changes by not more than 5 dB. The mute threshold can be pre-set at any level over a large range. A reduction of input to 0·25 dB below the muting threshold produces a 40 dB reduction in audio output level.

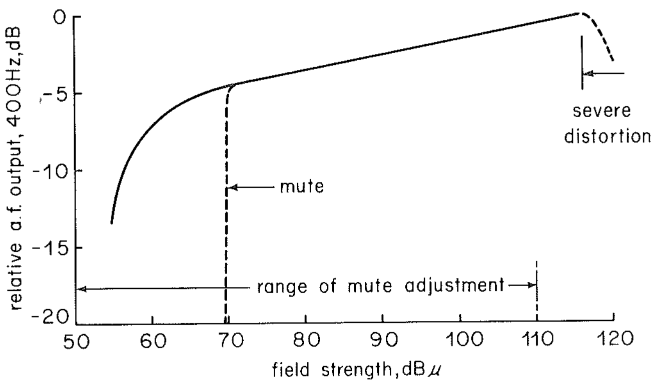

Fig. 2 - Input/Output characteristic

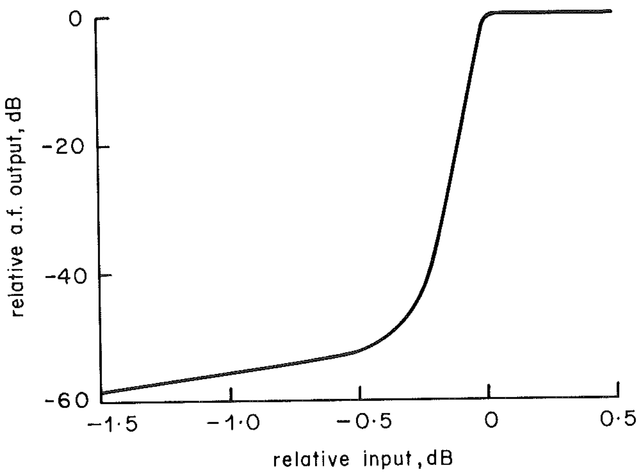

Fig. 3 - Mute characteristic

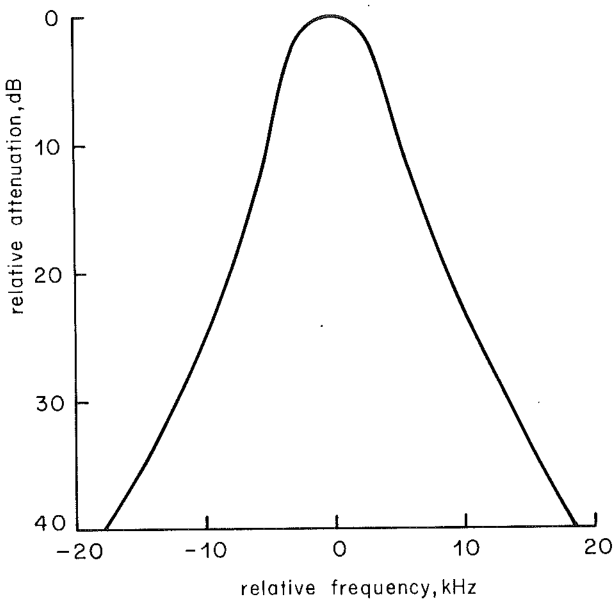

Fig. 4 - R.F. filter response

Figure 4 shows the r.f. filter response, the bandwidth at −3 dB being ±3 kHz. The relative attenuation at ±9 kHz is greater than 20 dB and at ±18 kHz is greater than 40 dB.

Figure 5 shows the overall modulation-frequency response of the receiver into a resistive load.

Figure 6 shows the ratio of signal to first-circuit noise, measured in the absence of ignition interference. The reference modulation is 30% at 500 Hz. This performance is more than adequate in the normal car

environment bearing in mind that, in urban traffic conditions, receiver noise is usually swamped by local impulsive interference.

Figure 7 shows the total harmonic distortion as a function of modulation depth for various output power levels, measured with a modulation frequency of 400 Hz. The distortion has little frequency dependence other than that imposed by the modulation-frequency response characteristic.

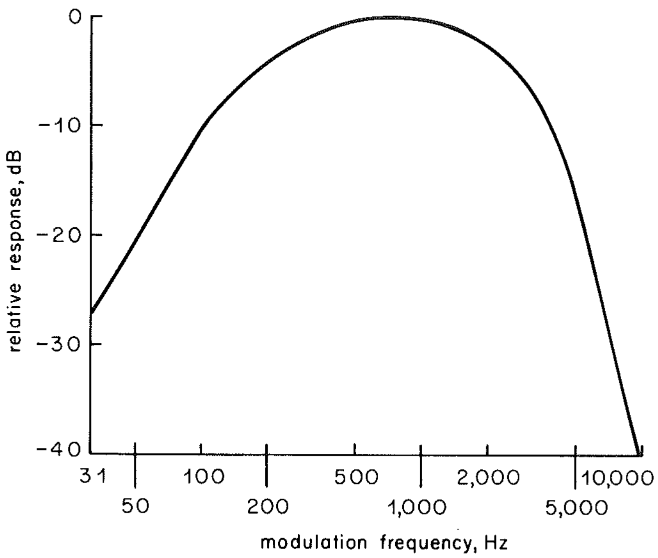

Fig. 5 - Overall modulation-frequency response into resistive load

4. Discussion

The design of the receiver has attempted to anticipate the requirements, both for economy and user convenience, of a service that does not yet exist. If and when such a service is instituted, practical experience may indicate that some features need to be modified.

For economy, it was thought desirable that the equipment should be capable of installation by motorists with no particular mechanical or electrical skill. The receiver with its built-in loudspeaker has therefore no fixed mounting, which would require drilling in the car, but is intended for loose stowage, for example on the shelf below the instrument panel. From the point of view of performance it would be preferable to mount the loudspeaker adjacent to the drivers head, this would permit running the receiver at a lower volume level with with consequently less disturbance to passengers and some reduction in the rating of the audio-frequency output stage, but this was thought to be impracticable for user installation.

Provision of a separate aerial for the traffic service receiver, even where the vehicle has an aerial for an existing car radio, offers a number of advantages. Firstly, it avoids the possibility of interaction between the two receivers, which would otherwise require a fairly complex active splitter unit. Secondly, it permits the traffic service receiver complete with its aerial and feeder to be supplied as a complete package. This allows the input tuned circuit to be pre-aligned in manufacture and also facilitates setting up the muting threshold in manufacture to occur at a pre-determined level in terms of field strength. The extent to which this would avoid the necessity for individual users to adjust the mute threshold in the field would depend on the degree to which the fringe-area field strength varied from point to point in each transmitter service area and from one service area to another. The receiver-plus-aerial package approach would at least avoid

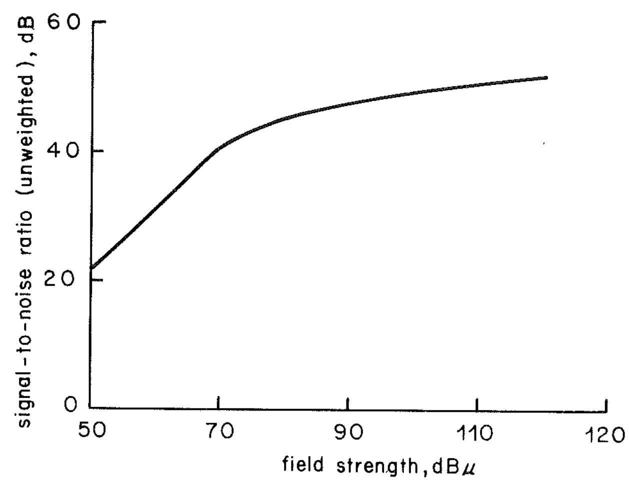

Fig. 6 - Signal-to-noise ratio

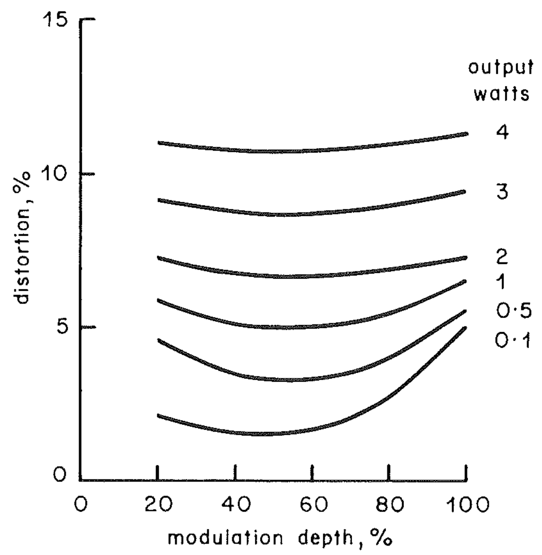

Fig. 7 - Distortion characteristic

the necessity for user adjustments to compensate for variations in aerial characteristics.

The type of aerial envisaged in the design stage of the receiver was that which clamps to the vehicle roof gutter. This was regarded as a reasonable compromise between mechanical durability and ease of installation. However, other types may be found preferable, for example, an adhesive metal-foil strip stuck to the inner surface of the windscreen.

The simple form of carrier-operated muting embodied in this receiver might be found in practice to be inadequate. This could occur if the channel used for the service were shared by other transmitters in Europe, and if the fringe-area field strengths of the traffic service transmissions were found to be substantially below the nominal level over a significant portion of the country. There would then be areas in which the night-time interference level from Continental stations approached or even exceeded the signal level obtained from the local traffic service transmitter. It would then be impossible with a simple carrier-operated circuit to secure reliable reception of the wanted signals without intermittent opening of the mute on interference.

This situation could be covered by a muting circuit operated by audio or infra-audio modulating signals radiated by the traffic service transmitters at the beginning and end of each transmission. If the production quantities of receivers were large enough to justify the manufacture of special-purpose integrated circuits, the additional cost of this muting device would presumably be small.

A further development of the principle of indentification signals preceding the announcements could provide means to inhibit reception of repeated messages that have already been received at an earlier transmission or to code messages into various classifications, e.g. for heavy vehicles only, with selective muting at the receiver to enable drivers to select only the type of information that they wish to hear.[2]

5. Conclusions

It has been suggested that a broadcast service of road information for motorists could be provided by a network of m.f. transmitters, all operating on a common carrier frequency on a time-sharing basis.

This report describes a simple fixed-tuned receiver suitable for use with such a service. Its principal features are a muting circuit to silence the receiver in the absence of a strong local signal, an efficient a.g.c. system, and long-term stability of tuning.

6. References

1. SANDELL, R.S. 1974. Broadcasting traffic information to road vehicles. *Electronics and Power*, 1974, **20**, 9, pp. 371–373.

2. BBC, British Patent Application No. 40084/74.

CLA/JUC

Printed by BBC Research Department, Kingswood Warren, Tadworth, Surrey